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Supporting Information

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Visible Light Driven Oxidation of Organic Contaminants in Air with Gold Nanoparticle Catalysts On Oxide Supports

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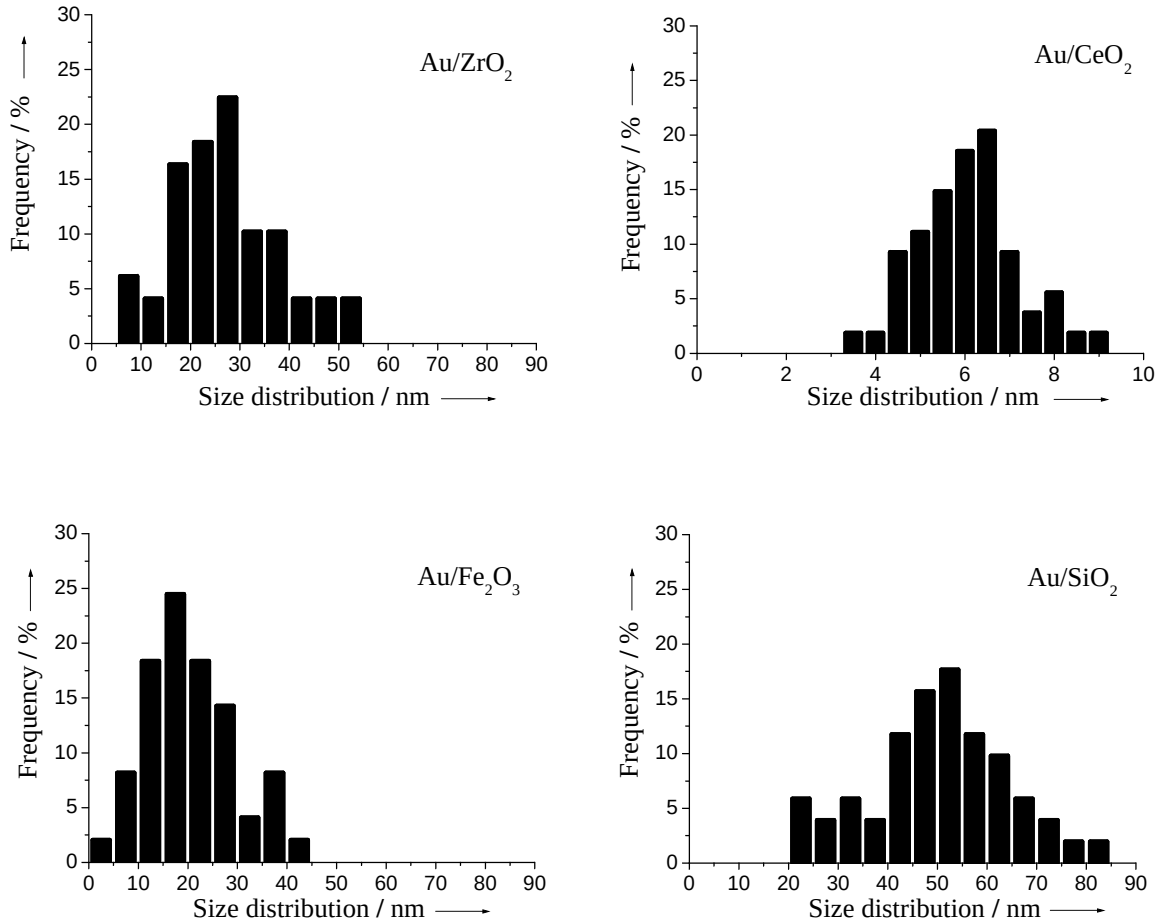
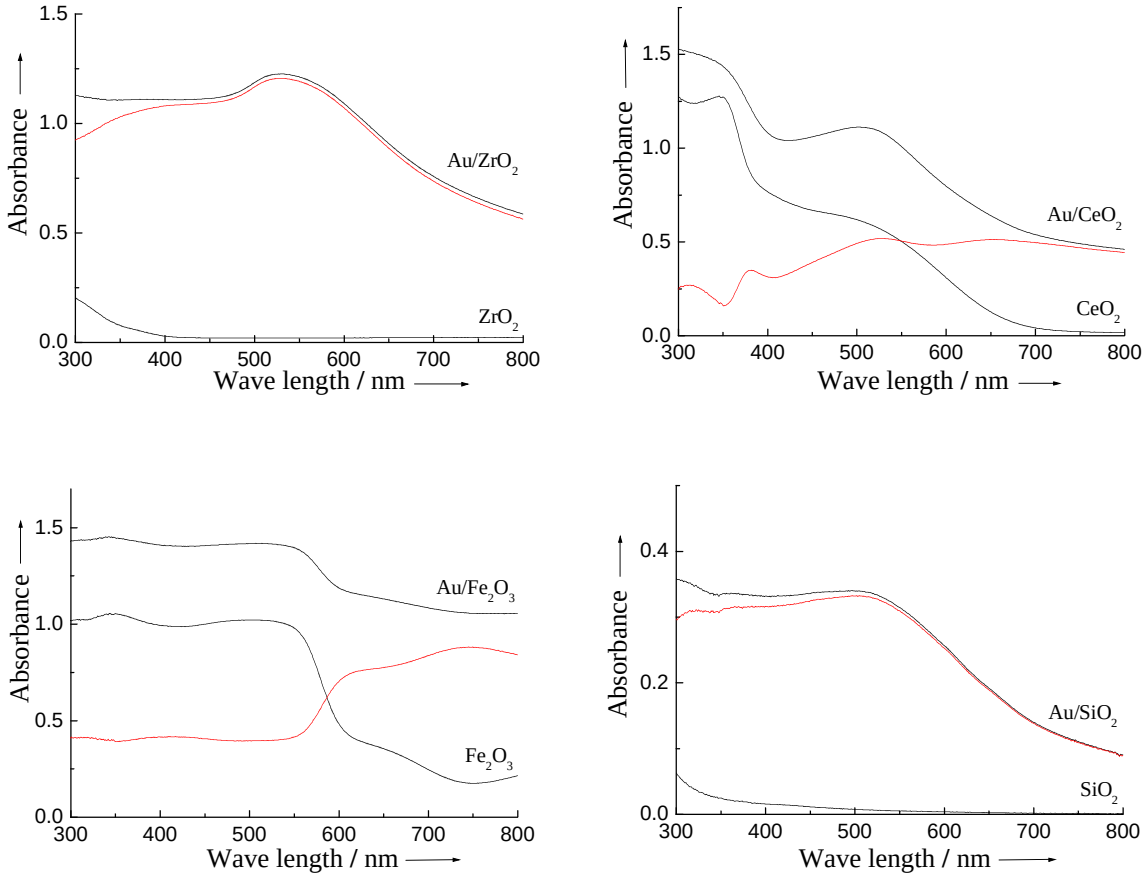
When illuminated with visible light, gold nanoparticles dispersed on oxide supports exhibited significant activity for oxidation of formaldehyde and methanol in air at room temperature. It is believed that the visible light is absorbed by gold nanoparticles due to surface plasmon resonance effect, and the particles are heated up quickly to a temperature at which the organic molecules are activated to react with oxygen. Because the light heats the gold nanoparticles only, it requires much lesser energy input to activate the reaction, compared to conventional catalytic oxidation under directly heating. This finding reveals the possibilities to drive other reactions with abundant sunlight on gold nanoparticles at ambient temperature.

The size distributions of the gold nanoparticles on four supports were calculated from the TEM images and given in Supporting information (SI Figure 1). The distributions on ZrO_2 and SiO_2 are broad, and with peak values at 27 and 53 nm, respectively. Most of the gold nanoparticles on CeO_2 are below 10 nm, and most of the particles on Fe_2O_3 supports are between 10 and 30 nm. The mean sizes of gold particles on are in an order of $Au/CeO_2 < Au/Fe_2O_3 < Au/ZrO_2$.

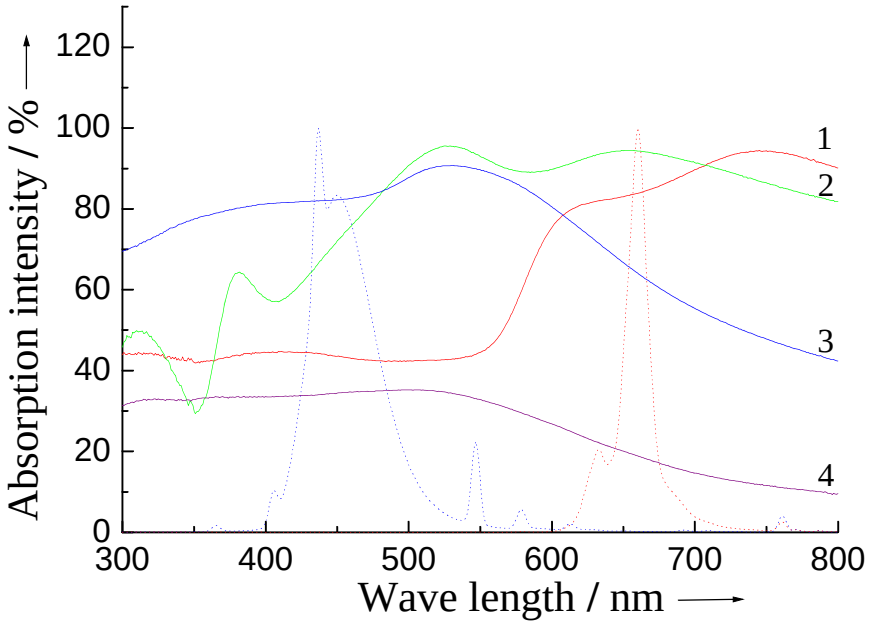


SI Figure 1. Size distribution of the gold nanoparticles on four supports.

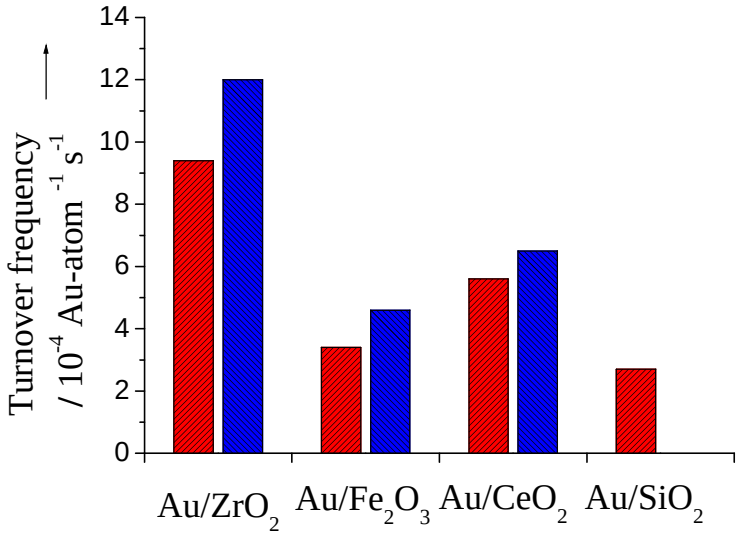
We can obtain the absorption spectra by the gold nanoparticles in a catalyst from the difference between the spectra of the catalyst and oxide support (SI Figure 2). The absorbed irradiation energy by the gold nanoparticles is then derived from the overlap area of the absorption spectrum of the gold nanoparticles and the spectra of the irradiation tube sources (SI Figure 3) as well as the irradiation energy (for instance 0.17W/cm^2 for blue light). The turnover frequency per unit of the irradiation energy absorbed by gold nanoparticles of the catalysts, normalized turnover frequency, was calculated with the data of gold content and HCHO conversion of the catalyst. The absorbed energy by the gold nanoparticles on SiO_2 is lower than those particles on other oxides. This could be an important reason for the relative low activity of Au/SiO_2 sample. The activities of the catalysts on various oxides in the normalized turnover frequency are given in supporting information (SI Figure 4).



SI Figure 2. UV-Visible spectra of Au/ZrO_2, Au/CeO_2, Au/Fe_2O_3, Au/ZrO_2 and Au/SiO_2, the spectra are also compared with those of the corresponding oxide support. Absorption spectra by the gold nanoparticles in a catalyst are obtained from the difference between the spectra of the catalyst and oxide support.



SI Figure 3. Absorption intensity of gold nanoparticles on different supports. 1) Au/Fe_2O_3; 2) Au/CeO_2; 3) Au/ZrO_2 and 4) Au/SiO_2. Blue dot line shows irradiation intensity of six blue light lamps, while the red dot line shows irradiation intensity of six red light lamps.



SI Figure 4. The influence of the oxide supports on the turnover frequency of HCHO oxidation reaction. The bars in blue is the HCHO turnover frequency (in 10^{-4} Au-atom^{-1} s^{-1}) under illumination of blue light (with wavelength between 400 and 500 nm) and the bars in red is the conversion under red light (with wave length between 600 and 700 nm).